



**CANADA'S LEADING  
DEVELOPER OF INDUSTRIAL  
OPTICS AND PHOTONICS  
SOLUTIONS**

# CubeSat Cameras

## 2nd Planetary CubeSat Science Symposium

Denis Dufour, Christian Proulx and François Châteauneuf

- **Who is INO**
- **Uncooled Microbolometers**
- **Microbolometer-based Cameras**
- **Custom Packaging and Flight Heritage**
- **Future Developments**

# Key Facts\*



- **Founded in 1988**
- **199** employees
- **\$34.6M** operating
- **ISO 9001:2008**
- **ISO 13485:2003**

## Locations

- Quebec City (HQ)
- Hamilton ON
- Calgary AB



**6,000**  
R&D  
contracts

**256**  
Patents  
(81 pending)

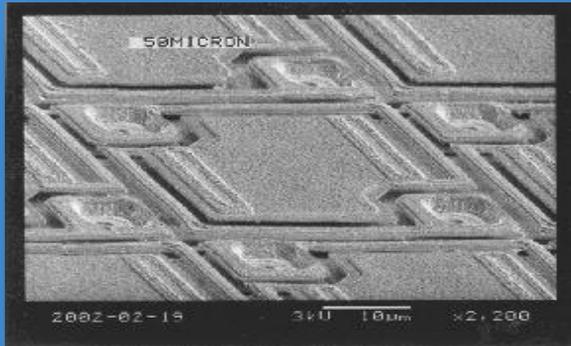
**69**  
Technology  
transfers

**32**  
Spin-offs

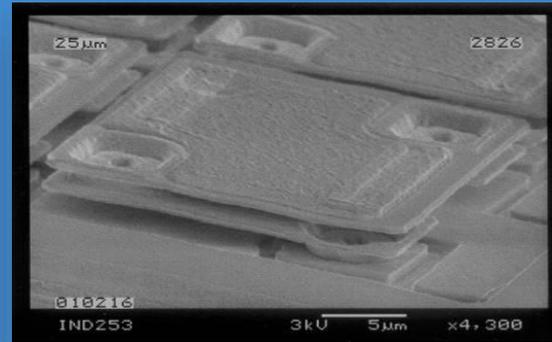
# Uncooled Microbolometer Technology



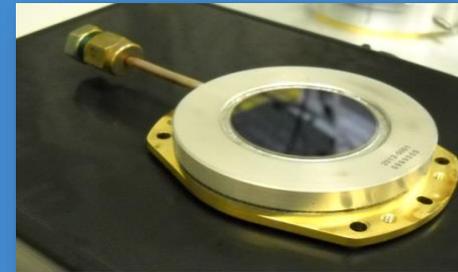
- Fabricated using MEMS surface micromachining techniques
- Based on vanadium oxide thin film thermistor technology



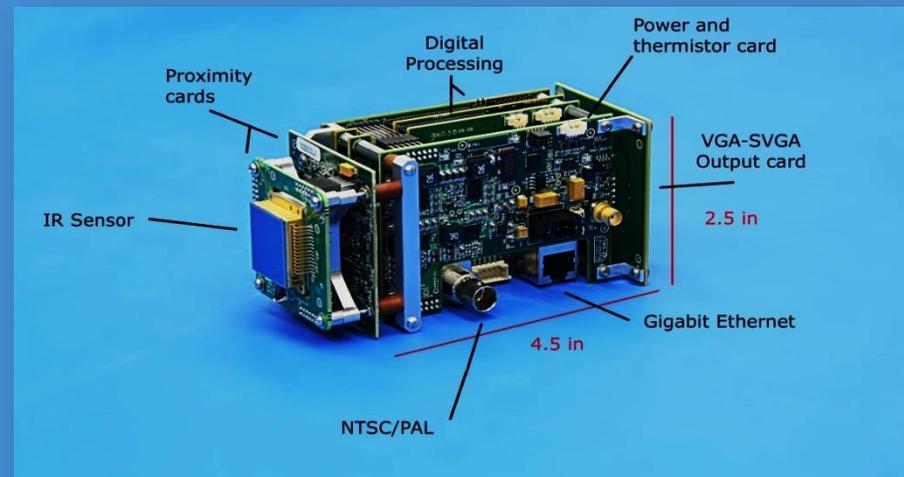
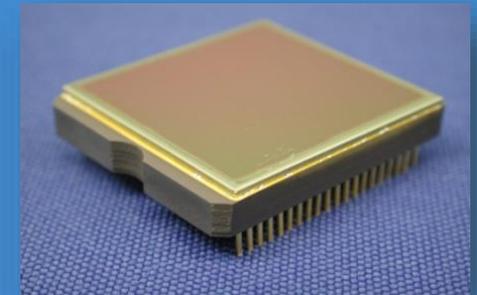
52  $\mu\text{m}$  pitch pixel array



25  $\mu\text{m}$  pitch pixel FPA



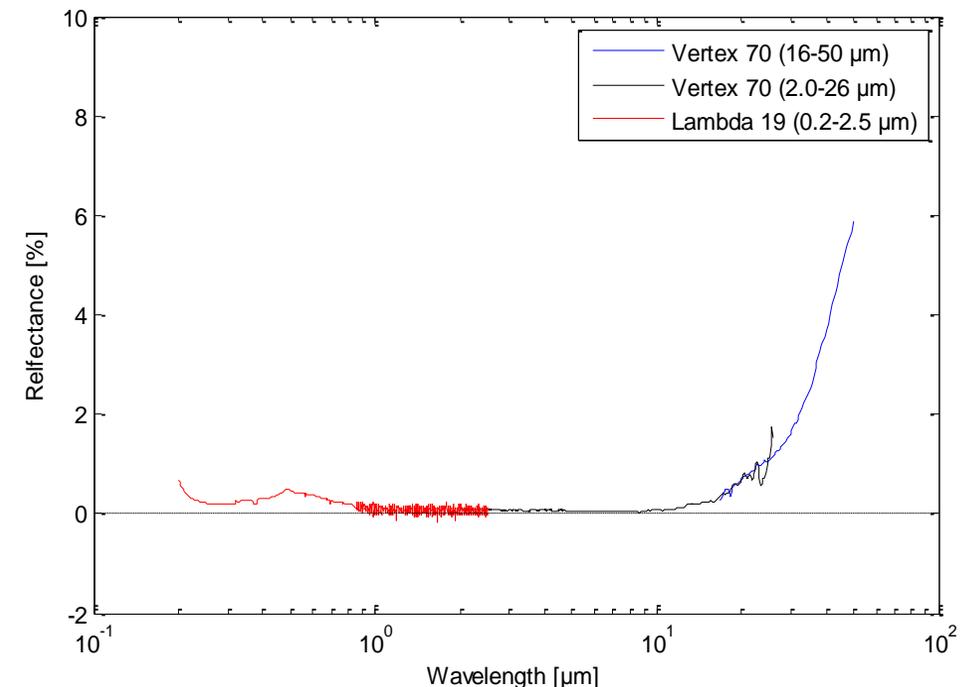
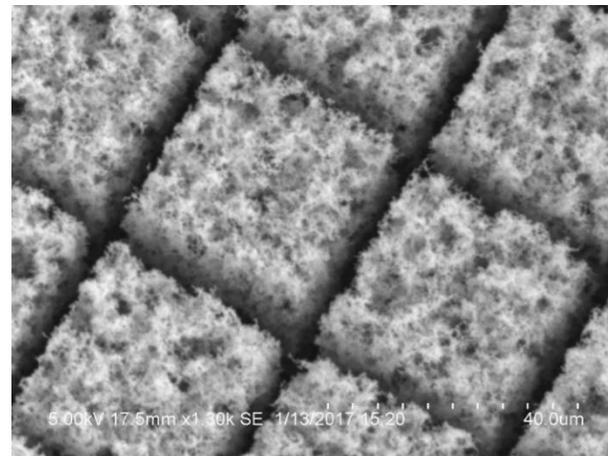
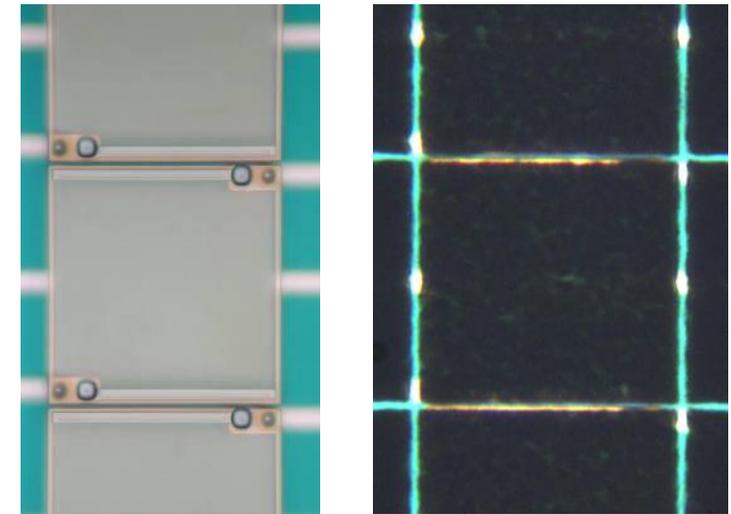
Vacuum packaging



# Broadband Absorber



- Gold black is a very good absorber film suitable for integration with fast MEMS thermal sensors
- With financial support from the Canadian Space Agency, INO has established a new gold black facility including deposition and laser trimming stations
- Gold black layer can be tailored between 25 and 40  $\mu\text{m}$  of gold black
- Laser trimming of gold black to singulate and preserve the electrical and thermal isolation of each pixel
- Integration with microbolometer detectors is performed on a regular basis
  - Measured pixel level absorption is above 90 % from visible to far infrared
  - Detector thermal capacity increased is less than 50 %

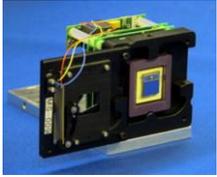
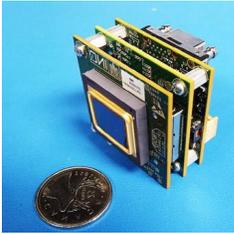


# IR and THz Camera Cores



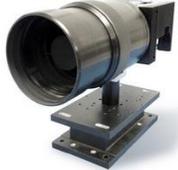
## IR Camera Cores



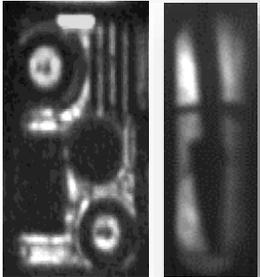
2007	2008	2009	2010	2012	2015
 <p>Mimic II V2 160x120 Digital Output</p>	 <p>IRXCORE 640x480 Camera Link Output</p>	 <p>IRXCAM 640x480, 160x120 Onboard Processing GigE Output</p>	 <p>IRXCAM-1024 1024x768</p>	 <p>IRXCAM-384 384x288</p>	 <p>µXCAM-384 288x384</p>

## High Resolution Camera Cores with Microscan



 <p>HRXCAM-1280 Microscan Optics 1280x960</p>	 <p>HRXCAM-2048 Microscan Optics 2048x1536</p>	 <p>HRXCAM-16K Microscan Optics 16384x12288</p>
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## Terahertz Camera Cores

 <p>MIMICII-THZ-160 160x120</p>	 <p>IRXCAM-THz-160 160x120</p>	 <p>IRXCAM-THz-384 384x288</p>	 <p>µXCAM-THz-384 288x384</p>
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# Custom Packaging and Flight Heritage



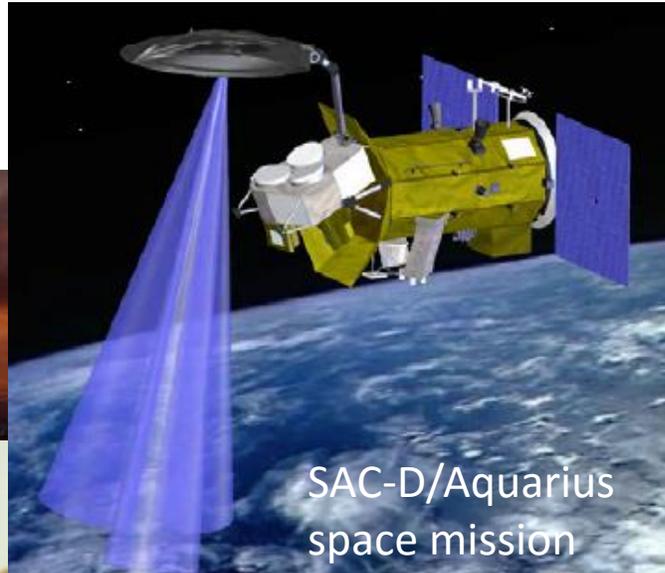
- Throughout the years, INO has often worked with space agencies to package bolometers
  - Several missions and applications
  - Various packaging requirements



Broadband radiometer



Volcanic eruption thermal monitoring



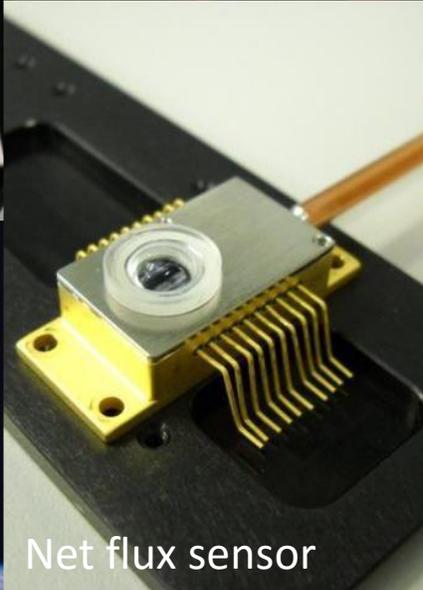
SAC-D/Aquarius space mission



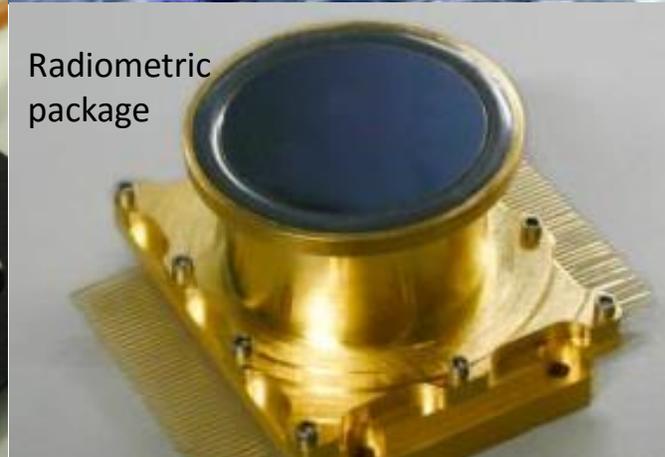
WSCFI package  
Courtesy of Canadian Space Agency



EarthCARE satellite



Net flux sensor



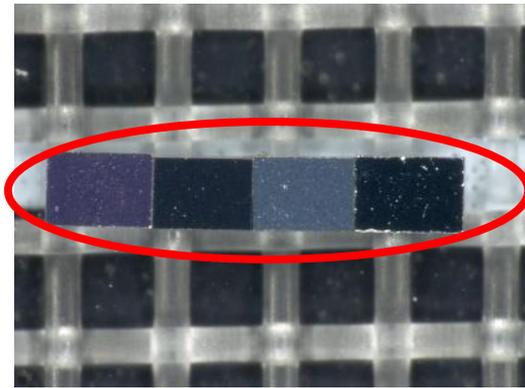
Radiometric package



Forest fires thermal monitoring

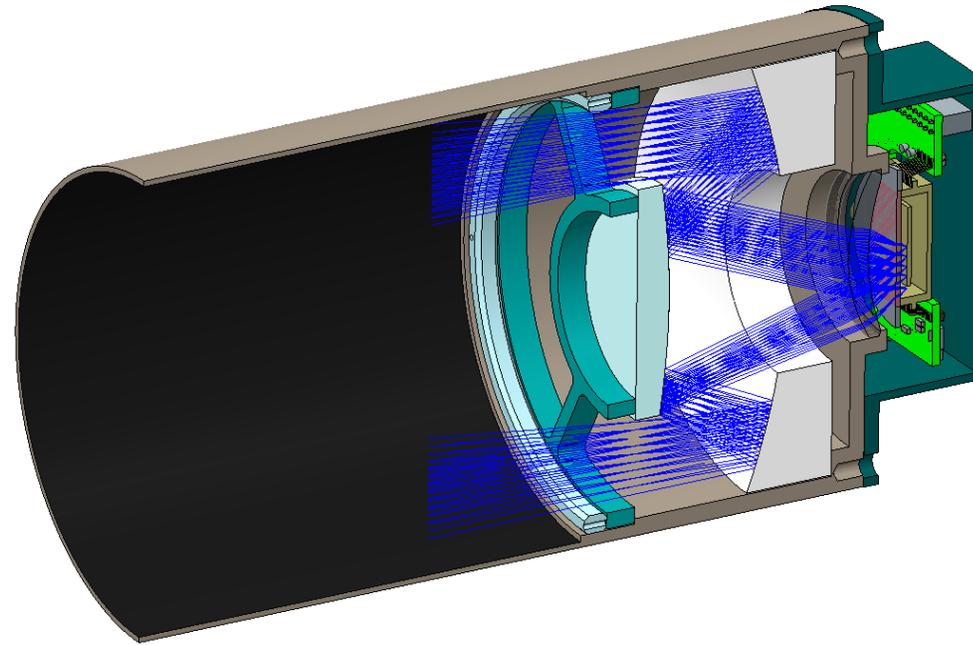
- Butcher Block filter located in front of the focal plane array

4x1 butcher block on Gel-Pak

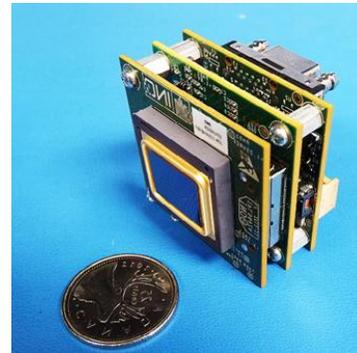
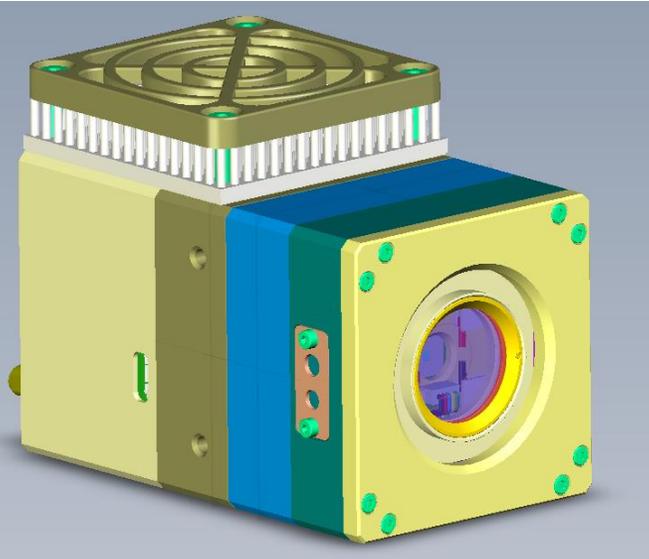


508  $\mu\text{m}$

4 x 572  $\mu\text{m}$



## Modular Benchtop MWIR-LWIR imaging spectrometer

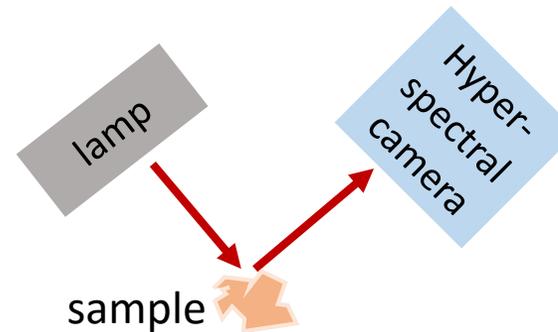


*μXcam-384*

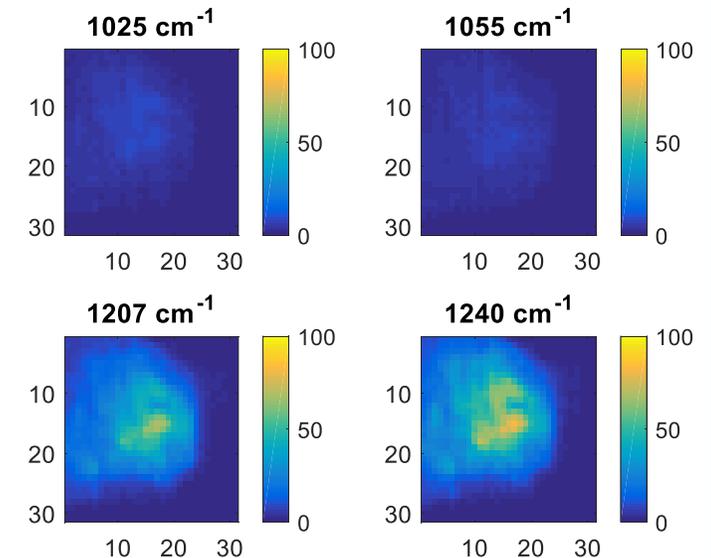
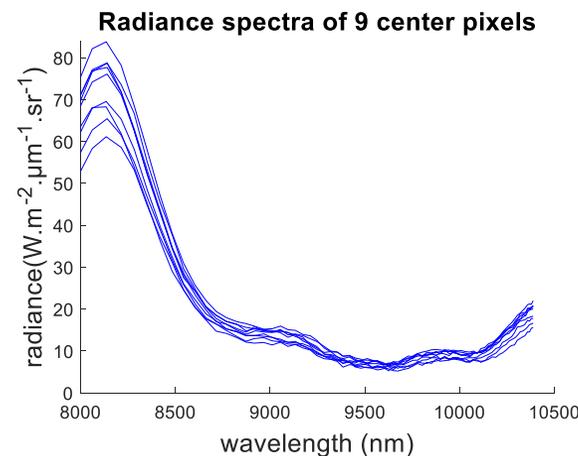
61mm x 78.5mm x 101mm

- Based on Fabry-Pérot Interferometer (FPI) and INO *μXcam-384* camera with goldblack-coated microbolometers
- Adaptable to a wide range of possible IR wavelengths depending on chosen Fabry-Perot interferometer

## Preliminary tests in LWIR band



Visible image of a beryl-topaz sample





Thank you.

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